

Retention of vinyl chloride in the human lung

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ABSTRACT Experiments with volunteers showed that 42% of an inhaled dose of vinyl chloride is retained in the lungs. This value is independent of the concentration of vinyl chloride in the air. Elimination of vinyl chloride through the lungs is negligible since its concentration in expired air decreases immediately after the cessation of exposure.

Interest in the toxic action of vinyl chloride (VC) has grown recently following the increased incidence of hepatic angiosarcoma found among VC polymerisation workers.

In industry the main route of VC absorption is through the lung. No data on skin absorption in man are available, but it cannot be excluded since the compound was found to penetrate the skin of exposed monkeys.¹ The retention rate of VC in the lung was reported by Buchter *et al*² to be 26-28%, but these results were obtained from only two individuals exposed to 2.5 ppm VC and may thus be subject to error. The purpose of the present study was to determine the percentage retention of VC in the lung in man.

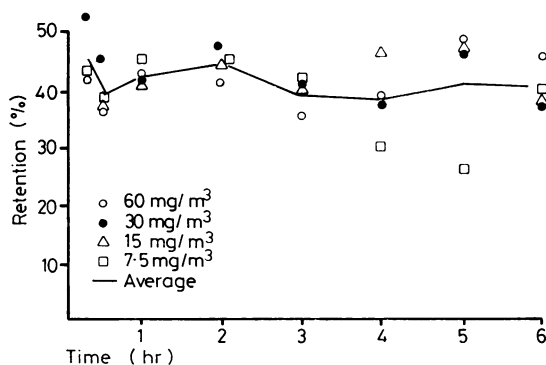
Method

Five healthy male volunteers aged from 26 to 31 were carefully examined by a doctor before and after exposure, and medical supervision was provided for each experiment. The volunteers were exposed to four atmospheric concentrations of VC with a 1 m³ toxicological chamber serving as the source of VC-air mixtures. VC monomer from a pressure cylinder was mixed with precleaned air in a two-step flow-dilution system to give the final concentrations. Volunteers were exposed for six hours to VC concentrations 60 mg/cm³ (24 ppm), 30 mg/cm³ (12 ppm), 15 mg/cm³ (6 ppm), and 7.5 mg/cm³ (3 ppm); values equal to 2, 1, 0.5, and 0.25 of the Polish maximum allowable concentration respectively. The subject remained outside the chamber and inhaled the air from inside through a gas mask connected with the interior of the chamber.

Samples of inhaled air were collected into 500 cm³ gas pipettes every five minutes, the expired air was sampled using charcoal tubes, and four to five 10-minute samples were taken every hour. The VC concentration in both the inhaled and the expired air was determined by gas chromatography³; determinations were possible down to 0.3 mg/m³. The difference between the concentration in the inhaled and expired air was calculated to obtain the percentage retention of VC in the lung. Samples of exhaled air were also collected for the first 90 minutes after the cessation of exposure to determine the rate of elimination of VC from the lung.

Results and discussion

The percentage retention of VC in the lung is shown in the figure. The value was independent of the VC concentration, averaging 42% and reaching the highest level of 46% in the first 15 minutes of exposure. In all the experiments the retention rate



Percentage retention of vinyl chloride in the lung.

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Table 1 Vinyl chloride concentration in expired air at end of exposure

In inhaled air (mg/m ³)	In expired air, last hour of exposure (mg/m ³)	In expired air	
		Mean value in first 30 minutes after exposure (mg/m ³)	Percentage of inhaled concentration
60.0	27.6	2.84	4.73
30.0	11.2	1.30	4.30
15.0	5.8	0.54	3.60

Table 2 Individual differences in retention rate at 30 mg/m³ vinyl chloride

Subject No	% retention at selected time points from start of exposure								
	15 min	30 min	1 h	2 h	3 h	4 h	5 h	6 h	6 hour mean
1	55.0	45.0	42.3	51.0	42.0	47.5	40.5	30.0	45.0
2	79.0	77.0	68.0	75.2	68.5	52.2	75.5	67.7	71.0
3	40.3	37.8	33.4	42.9	28.7	29.2	35.2	29.1	33.5
4	45.0	31.5	49.3	41.0	34.5	41.7	44.0	33.4	39.0
5	43.1	35.9	20.8	29.9	32.0	20.2	37.3	26.2	30.0
Mean retention	52.5	45.4	42.8	48.0	41.1	38.2	46.5	37.3	44.0
Standard deviation of mean S/ \sqrt{n}	7.1	8.2	6.5	7.6	7.2	5.9	7.4	7.7	8.6

dropped rapidly 30 minutes after exposure was begun and thereafter increased to a relatively constant level. A similar picture was observed by Rogaczewska⁴ for acrylonitrile.

Concentrations of VC in the expired air immediately after cessation of exposure are presented in table 1. The concentrations were extremely low and 30 minutes from the end of the exposure no more than 5% of the chamber concentration could be detected. The values accounted for about 10% of the concentration in the air expired during the last 30 minutes of the experiment. Results for the lowest chamber concentration, 7.5 mg/m³, were below the limits of detection of the method and are therefore omitted in table 1.

Considerable individual differences in retention

rate were observed as illustrated by the values obtained for exposure to 30 mg/cm³ (table 2).

References

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